Impacts of Cool Temperatures on Overwintering Survival of Glassy-winged Sharpshooter

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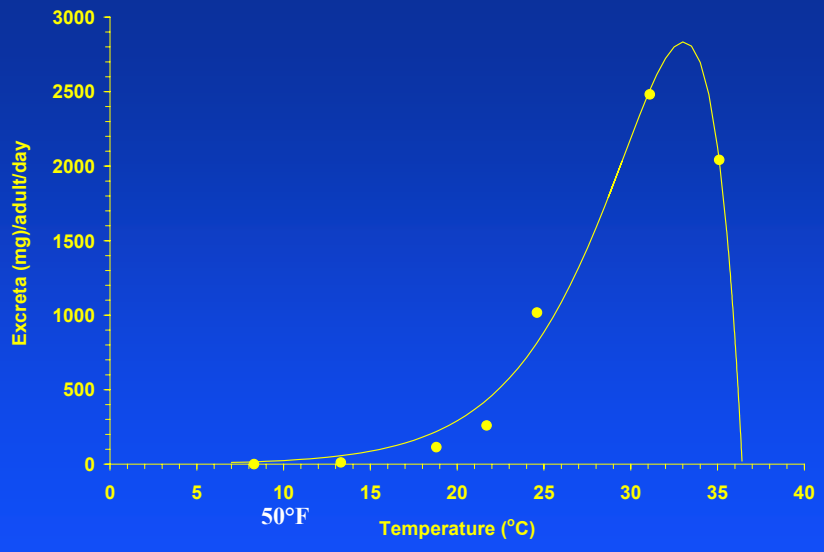
Potential factors influencing GWSS distribition in California

- Suitable host plants for feeding
- Suitable host plants for oviposition
- Natural enemies
- Agricultural practices and patterns
- Pesticide use patterns
- Urban communities
- Winter temperatures

Potential impacts of low winter temperatures on GWSS

- Pollard and Kaloostian (1961) observed that overwintering GWSS generally remained sessile at temperatures < 49°F and that first flights occurred only after the ambient air temperature ≥ 52°F.
- Russell Groves discovered similar temperature requirements for GWSS flight in sticky trap surveys conducted near Porterville, CA (Tulare Co.)
- Kern County Farm Advisor Don Luvisi proposed that feeding may stop when temperatures are low and obtained supportive data
- Our laboratory studies have 1) identified a temperature threshold range (ca. 48 - 50°F) below which feeding discontinues and 2) quantified GWSS's ability to survive without feeding (ca. 3 weeks)
- If the daily maximum temperature never exceeds the thermal threshold necessary for feeding, then GWSS overwintering survival may be limited by extended periods of cool temperatures in microclimatic regions of California, especially the Central Valley

Impact of temperature on xylem excreta production



Nonlinear Logan model (Logan et al., 1976) used to describe the relationship between temperature (°C) and the daily mean production of xylem excreta (mg) per GWSS adult on 'Eureka' lemon tree.

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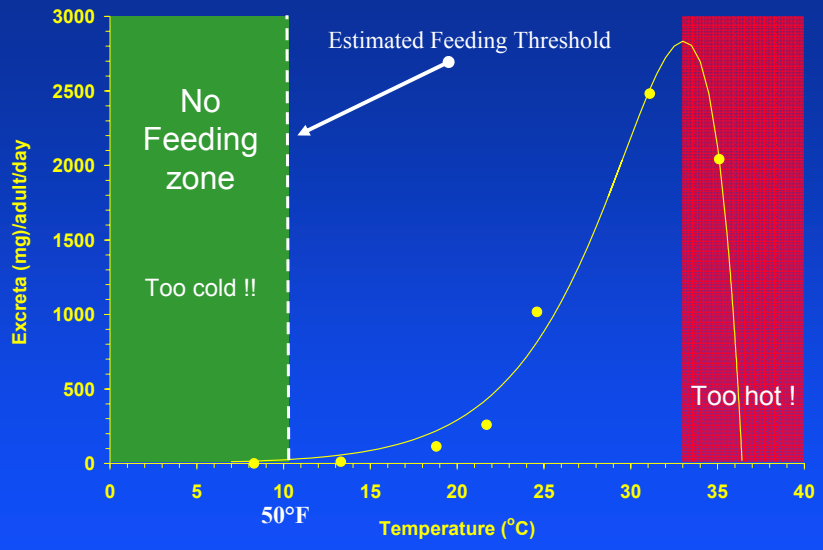

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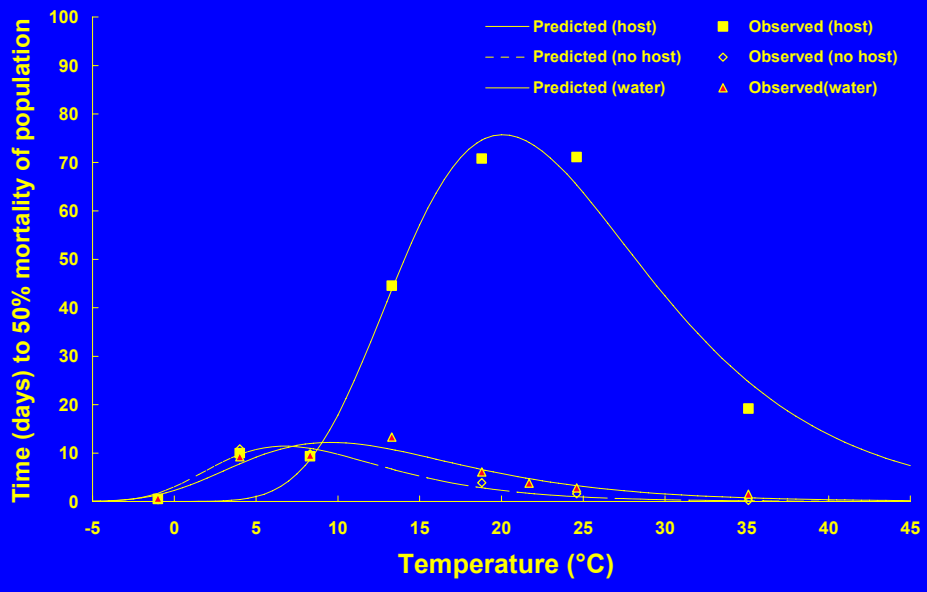
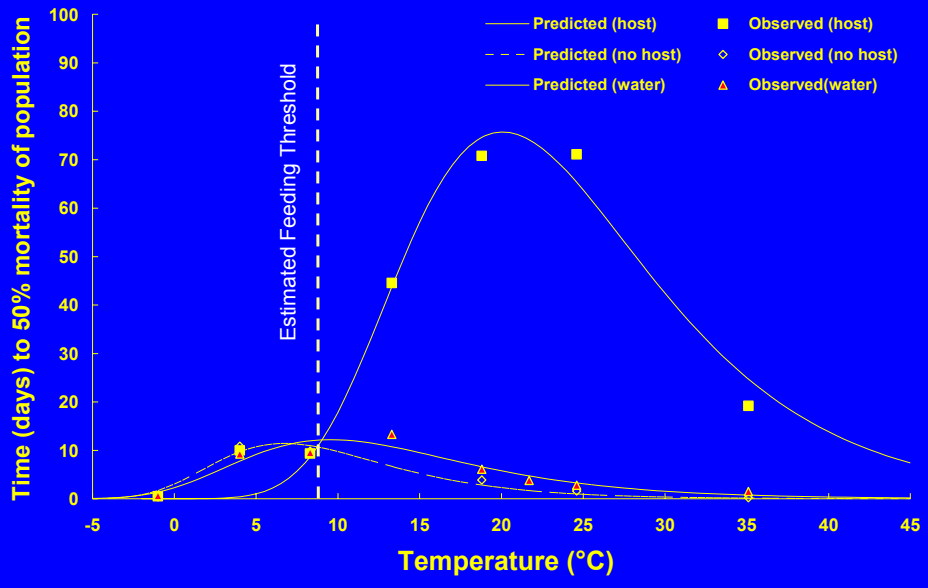


Effects of temperature on 50% mortality of GWSS adults under various feeding conditions.



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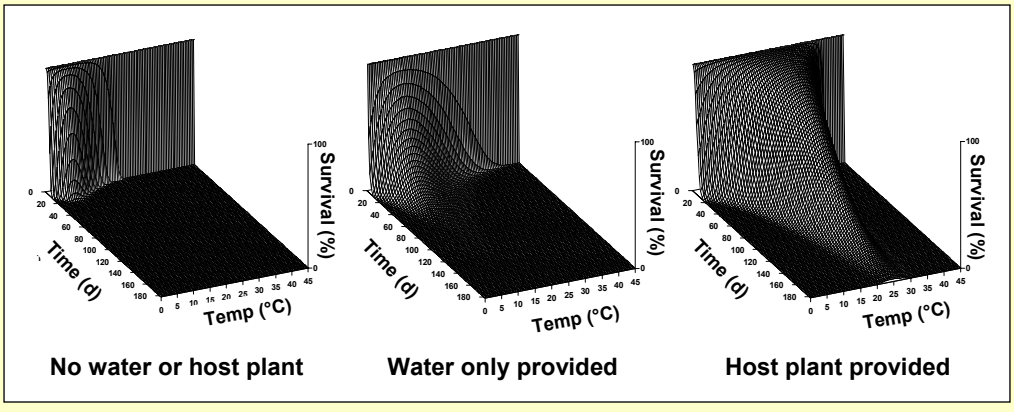
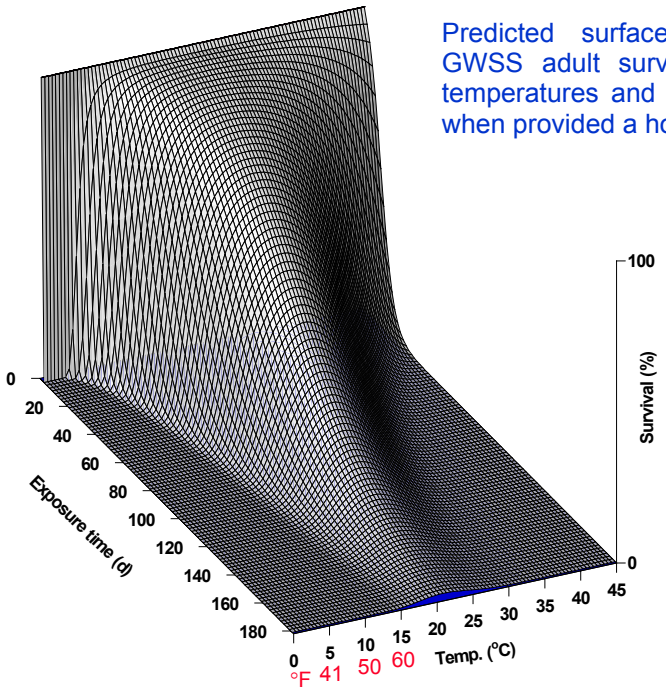
Interaction of Temperature and Exposure on GWSS Survival

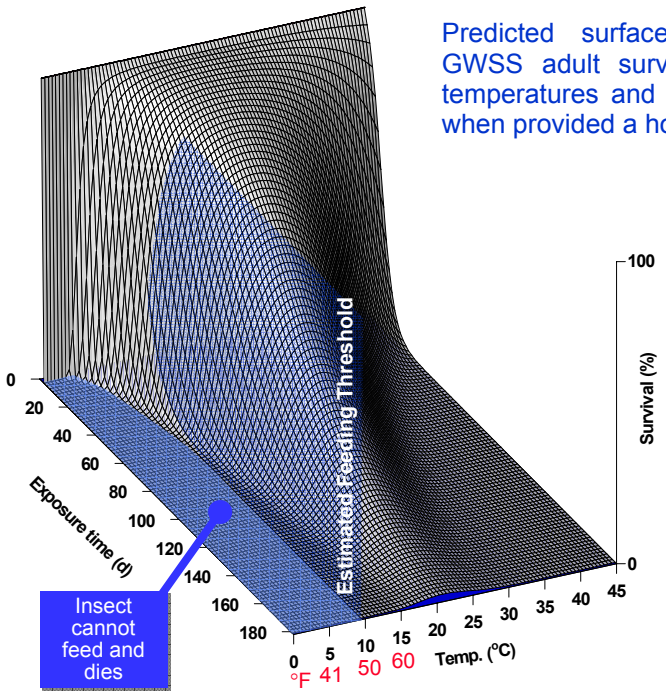


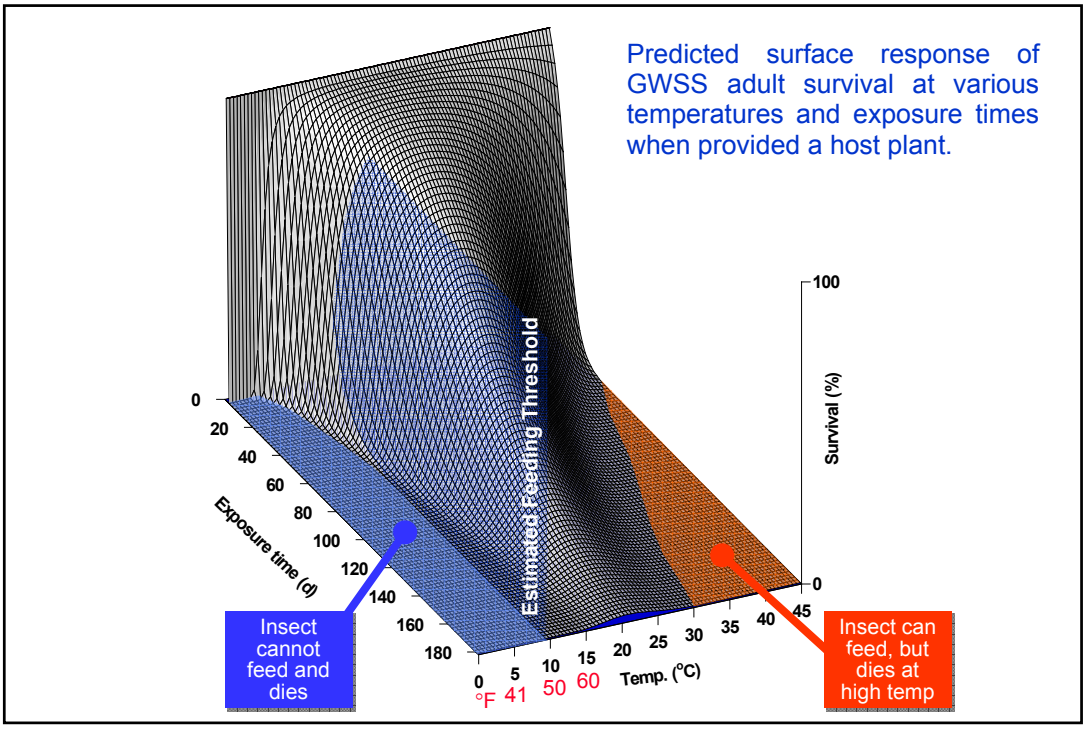
No water or host plant | Water only provided | Host plant provided

Predicted surface response of GWSS adult survival at various temperatures and exposure times when provided a host plant.



Predicted surface response of GWSS adult survival at various temperatures and exposure times when provided a host plant.



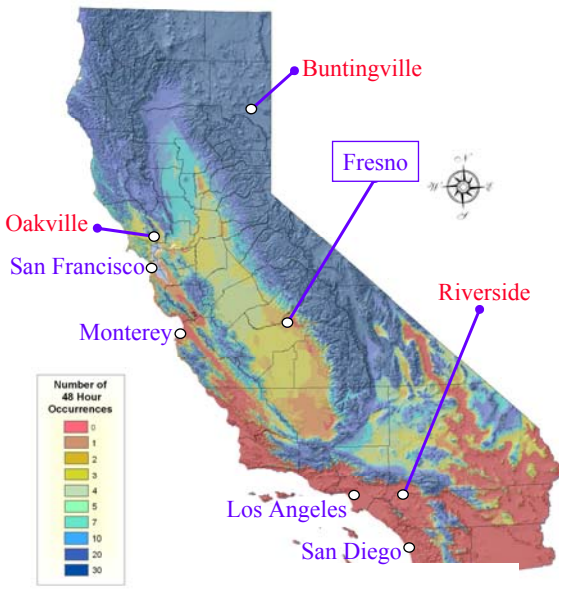


Study Objective

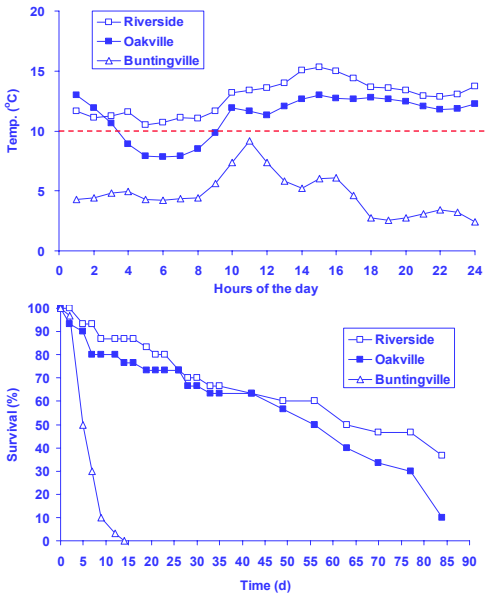
Quantify and predict the impact of cool temperatures (more than 0°F; less than 60°F) on the spatial population dynamics and overwintering success of GWSS in California's Central Valley

Temperature Cabinet Studies

- Although temperature cabinet studies showed that GWSS mortality was strongly related to percent survival, these studies were conducted under constant temperatures.
- To simulate field conditions with diurnal cycles, three locations in CA were selected and their temperatures for 1 January 1993 were programmed for every 2 hours to give a diurnal curve. Locations selected represented southern CA high desert (Riverside / Riverside County), north central CA coastal (Oakville / Napa County), and northeast CA mountain (Buntingville / Lassen County) climates.
- Ten GWSS adults were held under each temperature regime and survival recorded over a 95 day period. Treatments were replicated three times.
- Under the Buntingville conditions, all GWSS were dead within 15 days. In Riverside and Oakville, insects lived as long as 85 days, with survivorship higher under Riverside conditions (ca. 40%) vs. Oakville (ca. 10%).
- This study indicated the possibility of reduced overwintering survival based on location in CA.



Number of 48 hour periods below 50°F during January 1993



Percent survival of GWSS adults under fluctuating temperatures that simulated temperature cycles at Riverside, Oakville, & Buntingville, California.

Field Cage Studies

- Field studies were planned for this project, but concerns in quarantined areas over potential escapes of caged GWSS individuals overrode the "need to know."
- Permission was granted to establish a field cage site in Bakersfield (Kern County) at the Mt. Vernon UCCE County Office. A second site was established at Agricultural Operations at UC Riverside.
- Fifty GWSS adults were released into each cage installed on top of potted plants of grape (*Vitis vinifera*, 'Pinot Noir') and citrus (*Citrus* spp., 'Camizo') on 29 November 2006. There were 9 replicates at each site.
- Temperatures were monitored using HOBO data loggers. The study ran from 29 November to 23 February 2007.
- GWSS adults at Bakersfield experienced 100% mortality in mid-January 2007 whereas 8.4% of GWSS at Riverside remained alive at that time.
- The number of surviving adults at Riverside decreased to 0.4% by late February. GWSS egg masses were observed in at least one cage by that time.

Results of field cage tests at Bakersfield and Riverside

Intial number of adults in late November 2006 was 50 per cage. Total of 18 test cages for 2 different sites (9 cages per site).

	Mean No.s of GWSS Individuals	
Date[a]	Bakersfield	Riverside
Dec I	17.1 ± 2.2	18.7 ± 1.6
Dec II	10.2 ± 1.8	14.4 ± 1.6
Dec III	6.2 ± 1.5	5.6 ± 1.0
Dec IV	4.8 ± 1.4	4.8 ± 1.2
Jan I	0.9 ± 0.5	4.9 ± 1.1
Jan II	0.0 ± 0.0	4.2 ± 1.1
Jan III	0.0 ± 0.0	1.1 ± 0.4
Jan IV	0.0 ± 0.0	0.9 ± 0.4
Jan V	0.0 ± 0.0	0.6 ± 0.3
Feb I	0.0 ± 0.0	0.3 ± 0.2
Feb II	0.0 ± 0.0	0.2 ± 0.1
Feb III	0.0 ± 0.0	0.2 ± 0.1
Feb IV	0.0 ± 0.0	0.2 ± 0.1

[a] Roman numericals indicate the week of the month.

Cooling Degree Days

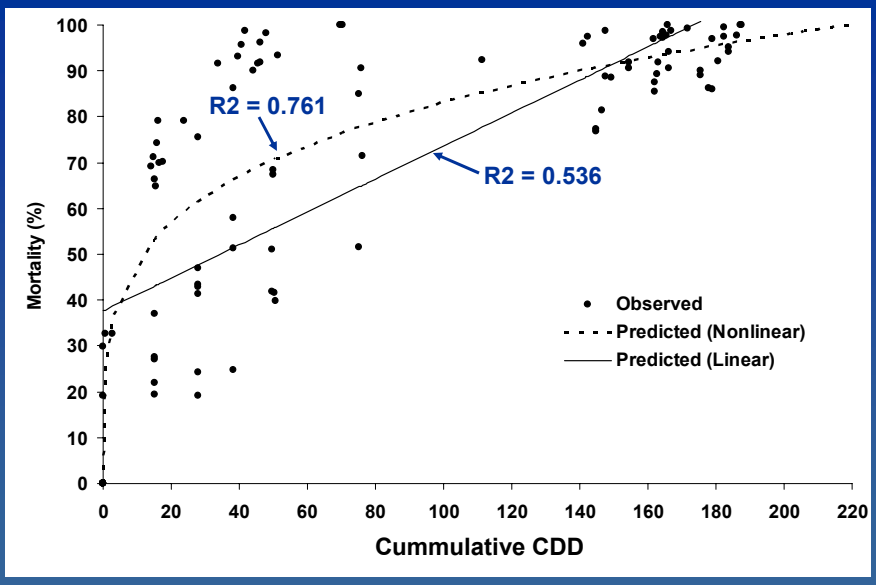
- Using GWSS mortality data and temperature records from 1) our field cage tests and 2) a field study conducted by Don Luvisi, *Emeritus* Farm Advisor, in 2001-2002 in the Bakersfield area, we were able to calculate Cooling Degree Days (CCD) using the following equations:

$$\text{Daily CDD} = |\, Tm - 50 \,|, \text{ if } Tm < 50^{o}\text{F} \quad [1]$$

$$= 0, \text{ if } Tm \geq 50^{o}\text{F} \quad [2]$$

  where 50ºF is the threshold temperature below which the GWSS feeding was inhibited

- The mortality of the GWSS was regressed against cumulative CCD for each treatment and replication.
- A nonlinear model predicted that 90 and 100% of GWSS mortality would occur at 143 and 215 CDD, respectively. The linear model predicted that 90 and 100% of mortality would occur at 148 and 175 CDD, respectively.

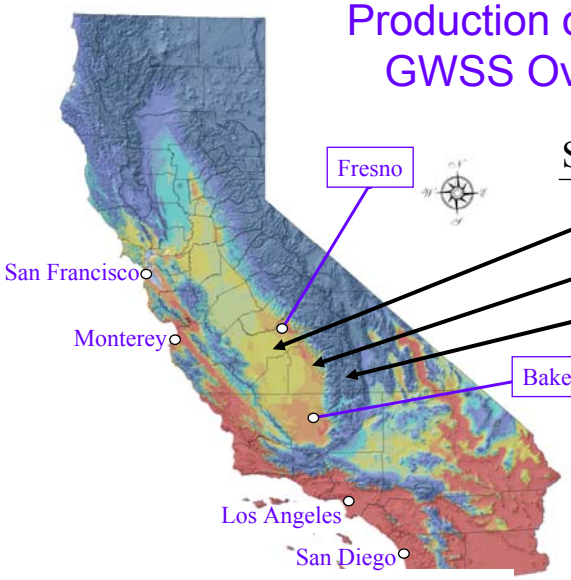


Linear (solid line) and non-linear (dotted line) regression models to predict the mortality (%) of GWSS adults based on cooling-degree days (CDD).

More Temperature Cabinet Studies

- Because of concerns over accidental release of GWSS individuals in quarantined areas, we cannot obtain permission to do needed field studies to verify overwinter mortality predictions for specific locations in CA
- Given this, we have selected 8 locations within CA for which we will simulate the diurnal temperature cycles for the months of November through March within temperature cabinets
- For each location treatment, we will record GWSS mortality weekly and estimate cumulative CDD, and verify the relationship between these two parameters using regression analysis
- Verification of a tight fit between GWSS overwintering mortality and cumulative CDD will allow us to use GIS mapping techniques to estimate locations within CA where GWSS populations will not survive the winter
- Such information can be used by regulatory agencies to better allocate limited resources for GWSS suppression in the springtime

Production of GIS Maps to Predict GWSS Overwintering Survival



San Joaquin Valley Conditions

- Cold, foggy valley floor
- Warmer "Banana belt"
- Cold foothill elevations

With predictive maps, we may be better able to use limited resources to eliminate problematic GWSS populations in the springtime

Summary

- The impacts of constant temperatures and exposure duration on adult GWSS survival and feeding activity were quantified
- At temperatures ≤ 10°C GWSS mortality rates are accelerated and no xylem excretion was observed, suggesting no feeding activity
- Production of xylem excreta and survival were temperature-dependent, with a low temperature feeding threshold between 10 – 15°C
- Access to a plant host for feeding was a critical survival requirement at temperatures ≥ 20°C
- Our future studies will better define the impacts of low temperatures on feeding activities and mortality and will enable the identification of California regions where significant GWSS mortality may occur due to low winter temperatures